CONCENTRATION OF BIOPETROL SYNTHESIZED FROM OLEIC ACID THROUGH HETEROGENEOUS CATALYTIC CRACKING USING ZEOLITE AS CATALYST

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A thesis submitted in fulfillment of the
requirements for the award of the degree of
Bachelor of Chemical Engineering

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APRIL 2010

ABSTRACT

One of the main fatty acids in vegetable oil is oleic acid and it has the potential to replace petroleum fuels in the future. In this research, zeolite catalysts are used over the conversion of oleic acid into isooctane as the future biopetrol in a heating mantle at atmospheric pressure. The main purposed of studies is to improve the concentration of isooctane using heterogeneous catalytic cracking method with using 20g of zeolite catalysts. The effect of various rotation speed of sample at 600 rpm, 780 rpm, 960 rpm and 1140 rpm and dilution factor of isooctane to hexane at 10% are studied over the yield of biopetrol at 98^{o}C. Gas chromatography is used for the qualitative and quantitative analysis of the samples. Backward calculation is applied to calculate the actual concentration of isooctane in the distilled oleic acid. The maximum yield of desired isooctane obtained at 1140 rpm with 20g of catalyst and dilution of 10% isooctane to hexane is recorded at 11.67 %. Experimental works has successful show that heterogeneous catalytic cracking is greater in conversion than catalytic cracking (static catalyst) and thermal cracking.

ABSTRAK

Salah satu asid lemak utama di dalam minyak sayuran ialah asid oleic dan ianya mempunyai potensi yang tinggi untuk menggantikan bahan api petroleum dimasa depan. Dalam kajian ini, agen pemangkin Zeolite telah digunakan untuk memperolehi isooktana daripada asid oleik untuk dijadikan sebagai biopetrol pada masa akan datang dengan menggunakan pemanas mantel pada tekanan atmosphera. Tujuan utama kajian ini dijalankan adalah untuk memperbaiki kepekatan isooktana menggunakan kaedah penguraian agen pemangkin. Kesan perubahan jumlah kelajuan pusingan sampel pada kelajuan 600 ppm, 780 ppm, 960 ppm dan 1140 ppm serta faktor pencairan isooktana kepada heksana pada 10% dikaji terhadap penghasilan biopetrol pada suhu 98^{o}C. Alat Gas Kromatografi telah digunakan untuk kualitatif dan kuatitatif analisis semua sampel. Pengiraan semula kepekatan isooktana tanpa pencairan heksana digunakan untuk mengira kepekatan sebenar isooktana di dalam didihan asid oleik. Kepekatan maksimum isooktana dicatatkan pada 1140 ppm dengan 20g agen pemangkin dan pada 10% cairan isooktana kepada heksana iaitu sebanyak 11.67%. Experimen ini telah berjaya membuktikan penguraian menggunakan kaedah agen pemangkin lebih bagus berbanding kaedah penguraian agen pemangkin (statik agen pemangkin) dan penguraian haba.

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LIST OF SYMBOLS

P	-	Pressure
m	-	Mass
ΔH	-	Enthalpy change of reaction
ΔS	-	Entropy change of reaction
ΔG	-	Energy change of reaction
T	-	Temperature
ρ	-	Density
μ	-	Viscosity of liquid (Pa.s)
h	-	Heat transfer coefficient
^{o}C	-	Degree Celsius
kg	-	Kilogram
K	-	Degree Kelvin
m	-	Meter
n	-	Number of moles
L	-	Liter
rpm	-	Rotation per minute
ppm	-	Pusingan per minit

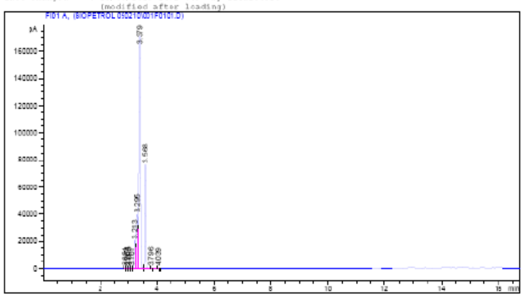
LIST OF APPENDICES

APPENDIX D

RESULT OF ISOOCTANE SAMPLES CHROMATOGRAM

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\001F0101.D
Sample Name: 5.1

Acq. Operator	: FIZa080210	Seq. Line :	1
Acq. Instrument	: Instrument 1	Location :	Vial 1
Injection Date	: 08/02/2010 11:29:30	Inj :	1
		Inj Volume :	1 µl
Acq. Method	: C:\CHEM32\1\METHODS\ISOOCTANE230108.M		
last changed	: 08/02/2010 11:27:14 by FIZa080210		
Analysis Method	: C:\CHEM32\1\METHODS\FATIMAH.M		
last changed	: 23/03/2010 14:27:59 by fiza230310 (modified after loading)		



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.854	BB	0.0298	18.72066	9.58111	0.00178
2	2.954	BV	0.0282	462.49344	254.41989	0.04387
3	3.005	VV	0.0321	1057.57312	512.74579	0.10032
4	3.101	VV	0.0362	112.79140	49.37572	0.01070
5	3.213	VV S	0.0451	5.80226e4	2.04491e4	5.50373
6	3.295	VV S	0.0634	1.50502e5	3.95508e4	7.27587
7	3.379	VV S	0.0640	6.55648e5	1.70690e5	76.19141
8	3.568	VB S	0.0410	1.87690e5	7.63836e4	10.80328
9	3.796	BB X	0.0284	684.96753	382.76996	0.06497
10	4.039	BB X	0.0276	43.06603	24.42961	0.00409

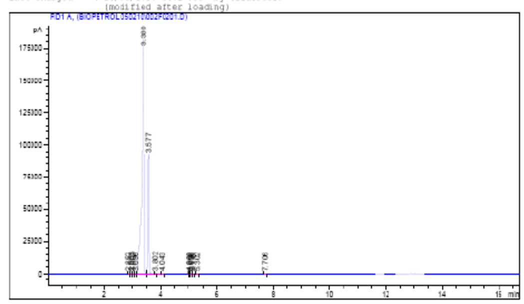
Totals : 1.05424e6 3.08307e5

Instrument 1 23/03/2010 14:28:32 fiza230310 Page 1 of 1

Sample W1

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\002F0201.D
Sample Name: 5.2

Acq. Operator	: FIZa080210	Seq. Line :	2
Acq. Instrument	: Instrument 1	Location :	Vial 2
Injection Date	: 08/02/2010 11:52:27	Inj :	1
		Inj Volume :	1 µl
Acq. Method	: C:\CHEM32\1\METHODS\ISOOCTANE230108.M		
Last changed	: 08/02/2010 11:27:14 by FIZa080210		
Analysis Method	: C:\CHEM32\1\METHODS\FATIMAH.M		
Last changed	: 23/03/2010 14:27:59 by fiza230310 (modified after loading)		



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.852	BB	0.0330	15.71223	7.33535	0.00113
2	2.953	BV	0.0304	489.82092	249.37095	0.03533
3	3.003	VV	0.0373	1230.73279	498.36448	0.08877
4	3.098	VV	0.0444	148.45074	53.43221	0.01071
5	3.390	VV S	0.1032	1.13380e6	1.83074e5	95.77394
6	3.577	VB S	0.0451	2.49738e5	9.23712e4	4.01212
7	3.802	BB X	0.0279	921.29828	514.86017	0.06645
8	4.043	BB X	0.0273	67.80051	38.07004	0.00489
9	4.988	BV	0.0295	3.59582	1.95548	0.00026
10	5.057	VV	0.0256	13.95321	8.29177	0.00101
11	5.090	VV	0.0281	22.53087	12.16937	0.00163
12	5.144	VB	0.0319	36.53710	17.85339	0.00264
13	5.302	BB	0.0458	7.52007	2.38290	0.00054
14	7.706	BB	0.0426	8.37160	2.99153	0.00060

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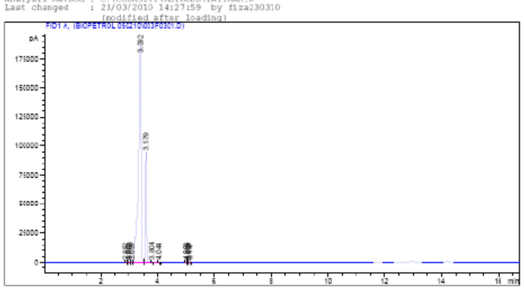
Sample W2

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\003F0301.D
Sample Name: 5.3

Acq. Operator	: FIZa080210	Seq. Line :	3
Acq. Instrument	: Instrument 1	Location :	Vial 3
Injection Date	: 08/02/2010 12:15:29	Inj :	1
		Inj Volume :	1 µl
Acq. Method	: C:\CHEM32\1\METHODS\ISOOCTANE230108.M		
Last changed	: 08/02/2010 11:27:14 by FIZa080210		
Analysis Method	: C:\CHEM32\1\METHODS\FATIMAH.M		
Last changed	: 23/03/2010 14:27:59 by fiza230310 (modified after loading)		



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.851	BB	0.0324	8.79781	4.04529	0.00061
2	2.953	BV	0.0303	395.92859	202.69168	0.02760
3	3.003	VV	0.0371	1114.81970	454.57092	0.07772
4	3.099	VV	0.0439	138.02977	49.62643	0.00962
5	3.392	VV S	0.0928	1.17216e6	1.86605e5	95.71922
6	3.579	VB S	0.0456	2.59471e5	9.47602e4	4.08945
7	3.804	BB X	0.0279	955.72607	533.05756	0.06663
8	4.044	BB X	0.0275	59.52671	33.07914	0.00415
9	4.990	BV	0.0297	3.64441	1.91197	0.00025
10	5.059	VV	0.0254	12.39534	7.43934	0.00086
11	5.092	VV	0.0290	20.95255	10.87782	0.00146
12	5.147	VB	0.0336	34.61784	16.10454	0.00241

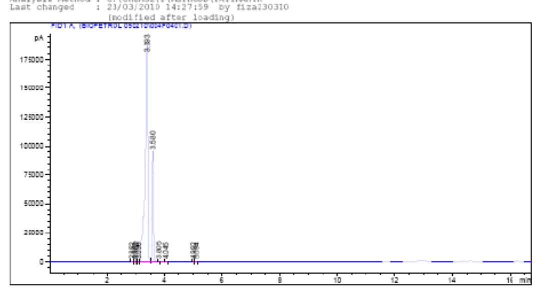
Totals : 1.43438e6 2.82679e5

Instrument 1 23/03/2010 14:32:23 fiza230310 Page 1 of 2

Sample W3

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\004F0401.D
Sample Name: 5.4

Acq. Operator	: FIZa080210	Seq. Line :	4
Acq. Instrument	: Instrument 1	Location :	Vial 4
Injection Date	: 08/02/2010 12:38:42	Inj :	1
		Inj Volume :	1 µl
Acq. Method	: C:\CHEM32\1\METHODS\ISOOCTANE230108.M		
Last changed	: 08/02/2010 11:27:14 by FIZa080210		
Analysis Method	: C:\CHEM32\1\METHODS\FATIMAH.M		
Last changed	: 23/03/2010 14:27:59 by fiza230310 (modified after loading)		



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.852	BB	0.0324	14.10363	6.60482	0.00096
2	2.952	BV	0.0303	487.58844	249.78642	0.03329
3	3.002	VV	0.0376	1268.75952	516.93018	0.08662
4	3.098	VV	0.0443	151.21490	53.86778	0.01032
5	3.393	VV S	0.1066	1.19745e6	1.87291e5	95.75231
6	3.580	VB S	0.0461	2.64315e5	9.55331e4	4.04527
7	3.805	BB X	0.0279	942.73285	526.21570	0.06436
8	4.045	BB X	0.0276	64.41265	35.63689	0.00440
9	4.992	BV	0.0309	3.45767	1.75913	0.00024
10	5.094	VV	0.0419	32.53473	10.71692	0.00222

Totals : 1.46473e6 2.84226e5

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Sample W4

Figure D.1: Sample W

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\005F0501.D
Sample Name: 6.1

Acq. Operator : FIZa080210 — Seq. Line : 5
Acq. Instrument : Instrument 1 — Location : Vial 5
Injection Date : 08/02/2010 13:01:48 — Inj : 1
Inj Volume : 1 µl
Acq. Method : C:\CHEM32\1\METHODS\ISOOCTANE230108.M
Last changed : 08/02/2010 11:27:14 by FIZa080210
Analysis Method : C:\CHEM32\1\METHODS\FATIMAH.M
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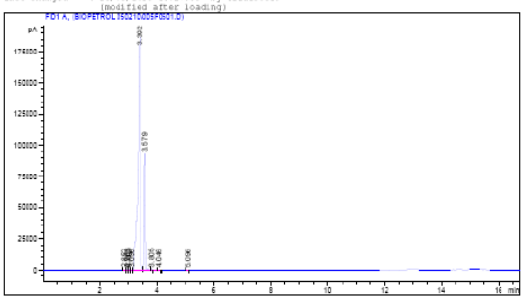

Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.852	BV	0.0320	48.34252	23.01971	0.00336
2	2.953	VV	0.0297	775.00403	397.83249	0.05382
3	3.003	VV	0.0366	1734.53455	719.46246	0.12045
4	3.098	VV	0.0432	170.34491	61.44441	0.01183
5	3.392	VV S	0.1054	1.17960e6	1.86614e5	9[illegible].91368
6	3.579	VB S	0.0460	2.56766e5	9.31316e4	[illegible].93014
7	3.805	BB X	0.0284	871.74005	485.69095	0.06054
8	4.046	BB X	0.0287	58.56289	31.34177	0.00407
9	5.096	BV	0.0370	30.53884	11.66797	0.00212
Totals :				1.44006e6	2.01476e5	

*** End of Report ***

Instrument 1 23/03/2010 14:35:08 fiza230310 — Pag 4 1 of 1

Sample X1

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\006F0601.D
Sample Name: 6.2

Acq. Operator : FIZa080210 — Seq. Line : 6
Acq. Instrument : Instrument 1 — Location : Vial 6
Injection Date : 08/02/2010 13:24:53 — Inj : 1
Inj Volume : 1 µl
Acq. Method : C:\CHEM32\1\METHODS\ISOOCTANE230108.M
Last changed : 08/02/2010 11:27:14 by FIZa080210
Analysis Method : C:\CHEM32\1\METHODS\FATIMAH.M
Last changed : 23/03/2010 14:27:59 by fiza230310
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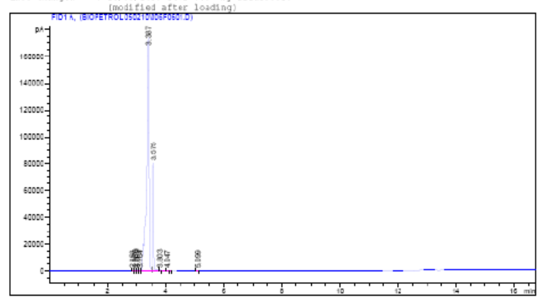

Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.858	BB	0.0317	18.28450	8.80699	0.00155
2	2.959	BV	0.0301	491.12982	253.57837	0.04175
3	3.009	VV	0.0354	1204.69165	512.23737	0.10240
4	3.104	VV	0.0407	128.16335	48.75300	0.01089
5	3.387	VV S	0.0921	9.61516e5	1.73960e5	95.72773
6	3.575	VB S	0.0438	2.12066e5	8.06055e4	4.02531
7	3.803	BB X	0.0293	722.75262	386.30143	0.06143
8	4.047	BB X	0.0291	315.70944	166.53760	0.02683
9	5.099	BV	0.0393	24.64240	8.88877	0.00209
Totals :				1.17649e6	2.55950e5	

*** End of Report ***

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Sample X2

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\007F0701.D
Sample Name: 6.3

Acq. Operator : FIZa080210 — Seq. Line : 7
Acq. Instrument : Instrument 1 — Location : Vial 7
Injection Date : 08/02/2010 13:48:08 — Inj : 1
Inj Volume : 1 µl
Acq. Method : C:\CHEM32\1\METHODS\ISOOCTANE230108.M
Last changed : 08/02/2010 11:27:14 by FIZa080210
Analysis Method : C:\CHEM32\1\METHODS\FATIMAH.M
Last changed : 23/03/2010 14:27:59 by fiza230310
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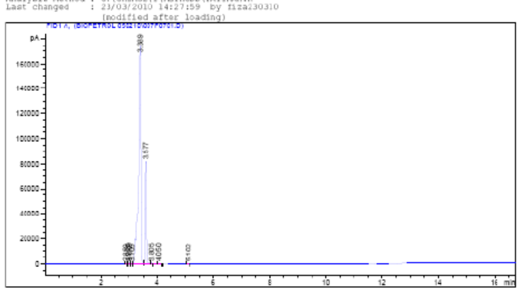

Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.859	BB	0.0321	20.17507	9.58378	0.00169
2	2.959	BV	0.0302	494.13562	253.85474	0.04140
3	3.010	VV	0.0350	1198.41663	503.12039	0.10041
4	3.105	VV	0.0413	126.90896	48.10557	0.01063
5	3.389	VV S	0.0931	9.75918e5	1.74779e5	9[illegible].77187
6	3.577	VB S	0.0436	2.14327e5	8.18446e4	[illegible].95782
7	3.805	BB X	0.0291	737.03784	389.29092	0.06175
8	4.050	BB X	0.0301	626.57056	316.77924	0.05250
9	5.101	BV	0.0394	22.91750	8.13618	0.00192
Totals :				1.19350e6	2.58153e5	

*** End of Report ***

Instrument 1 23/03/2010 14:36:35 fiza230310 — Page 1 of 1

Sample X3

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\008F0801.D
Sample Name: 6.4

Acq. Operator : FIZa080210 — Seq. Line : 8
Acq. Instrument : Instrument 1 — Location : Vial 8
Injection Date : 08/02/2010 14:11:17 — Inj : 1
Inj Volume : 1 µl
Acq. Method : C:\CHEM32\1\METHODS\ISOOCTANE230108.M
Last changed : 08/02/2010 11:27:14 by FIZa080210
Analysis Method : C:\CHEM32\1\METHODS\FATIMAH.M
Last changed : 23/03/2010 14:27:59 by fiza230310
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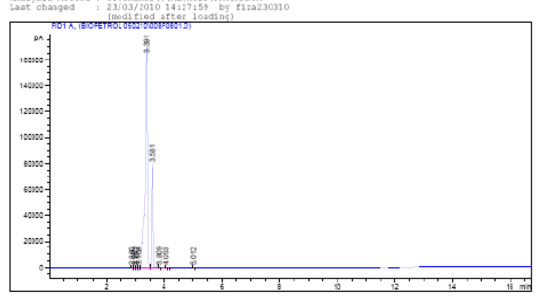

Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.860	BB	0.0311	22.76082	10.99853	0.00198
2	2.961	BV	0.0294	509.14935	264.82245	0.04432
3	3.012	VV	0.0350	1203.96277	519.63855	0.10480
4	3.108	VV	0.0402	125.56921	48.57297	0.01093
5	3.391	VV S	0.0916	9.39582e5	1.71041e5	9[illegible].78502
6	3.581	VB S	0.0433	2.06601e5	7.91369e4	[illegible].98391
7	3.809	BB X	0.0289	726.14099	395.91760	0.06321
8	4.053	BB X	0.0299	62.43838	31.84831	0.00543
9	5.012	BV	0.0350	4.67523	2.09768	0.00041
Totals :				1.14884e6	2.53852e5	

*** End of Report ***

Instrument 1 23/03/2010 14:37:21 fiza230310 — Page 1 of 1

Sample X4

Figure D.2: Sample X

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\009F0901.D
Sample Name: 7.1

Acq. Operator : FIZa080210 Seq. Line : 9
Acq. Instrument : Instrument 1 Location : Vial 9
Injection Date : 08/02/2010 14:34:28 Inj : 1
Inj Volume : 1 µl
Acq. Method : C:\CHEM32\1\METHODS\ISOOCTANE230108.M
Last changed : 08/02/2010 11:27:14 by FIZa080210
Analysis Method : C:\CHEM32\1\METHODS\FATIMAH.M
Last changed : 23/03/2010 14:27:59 by fiza230310
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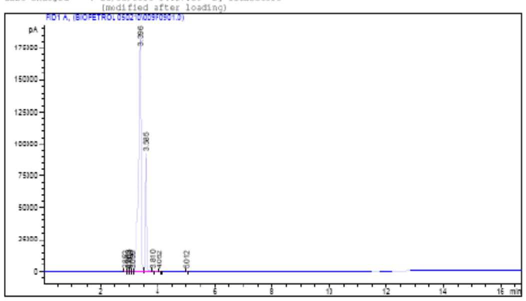


Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.852	BV	0.0327	36.44353	16.84476	0.00255
2	2.953	VV	0.0305	682.26031	346.33414	0.04766
3	3.004	VV	0.0373	1563.18909	633.42322	0.10920
4	3.099	VV	0.0450	166.46346	58.90368	0.01163
5	3.396	VV S	0.1067	1.17077e6	1.82958e5	[illegible].78394
6	3.585	VB S	0.0463	2.57362e5	9.26477e4	[illegible].97791
7	3.810	BB X	0.0272	890.01556	500.43295	0.06217
8	4.052	BB X	0.0289	64.49979	33.59546	0.00451
9	5.012	BV	0.0352	6.32664	2.76464	0.00044

Totals : 1.43154e6 2.77198e5

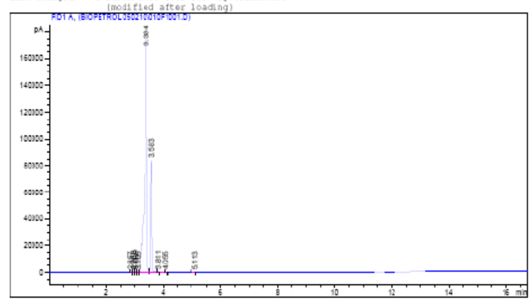
*** End of Report ***

Instrument 1 23/03/2010 14:38:12 fiza230310 Page 1 of 1

Sample Y1

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\010F1001.D
Sample Name: 7.2

Acq. Operator : FIZa080210 Seq. Line : 10
Acq. Instrument : Instrument 1 Location : Vial 10
Injection Date : 08/02/2010 14:57:45 Inj : 1
Inj Volume : 1 µl
Acq. Method : C:\CHEM32\1\METHODS\ISOOCTANE230108.M
Last changed : 08/02/2010 11:27:14 by FIZa080210
Analysis Method : C:\CHEM32\1\METHODS\FATIMAH.M
Last changed : 23/03/2010 14:27:59 by fiza230310
(modified after loading)



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.857	BB	0.0317	34.84271	16.82359	0.00275
2	2.958	BV	0.0302	652.56616	336.02924	0.05155
3	3.009	VV	0.0361	1474.16040	623.36537	0.11646
4	3.105	VV	0.0421	148.97646	55.81799	0.01177
5	3.394	VV S	0.0983	1.03649e6	1.75647e5	[illegible].88173
6	3.583	VB S	0.0448	2.26180e5	8.40656e4	[illegible].86806
7	3.811	BB X	0.0284	770.26434	420.43445	0.06085
8	4.055	BB X	0.0305	52.17012	25.88316	0.00412
9	5.113	BV	0.0457	34.25811	10.33274	0.00271

Totals : 1.26583e6 2.61202e5

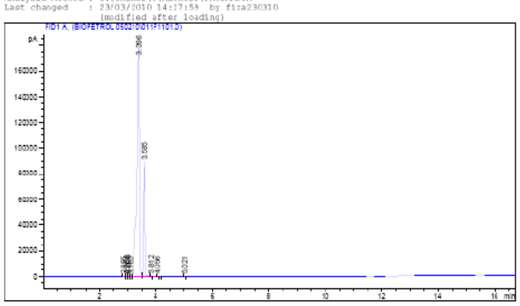
*** End of Report ***

Instrument 1 23/03/2010 14:38:57 fiza230310 Page 1 of 1

Sample Y2

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\011F1101.D
Sample Name: 7.3

Acq. Operator : FIZa080210 Seq. Line : 11
Acq. Instrument : Instrument 1 Location : Vial 11
Injection Date : 08/02/2010 15:10:54 Inj : 1
Inj Volume : 1 µl
Acq. Method : C:\CHEM32\1\METHODS\ISOOCTANE230108.M
Last changed : 08/02/2010 11:27:14 by FIZa080210
Analysis Method : C:\CHEM32\1\METHODS\FATIMAH.M
Last changed : 23/03/2010 14:17:59 by fiza230310
(modified after loading)



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.855	BV	0.0341	37.96225	17.00103	0.00277
2	2.956	VV	0.0308	670.73114	336.56328	0.04891
3	3.006	VV	0.0382	1582.42432	620.70123	0.11539
4	3.102	VV	0.0439	165.46385	57.83911	0.01207
5	3.396	VV S	0.1047	1.12175e6	1.78497e5	[illegible].80040
6	3.585	VB S	0.0461	2.46221e5	8.90867e4	[illegible].95499
7	3.812	BB X	0.0283	828.47089	454.24710	0.06041
8	4.056	BB X	0.0301	63.33534	31.36975	0.00462
9	5.021	BV	0.0362	6.03198	2.53373	0.00044

Totals : 1.37131e6 2.69104e5

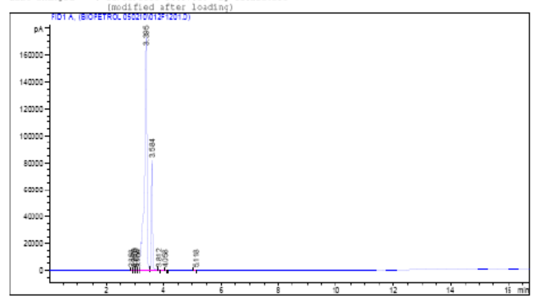
*** End of Report ***

Instrument 1 23/03/2010 14:39:39 fiza230310 Page 1 of 1

Sample Y3

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\012F1201.D
Sample Name: 7.4

Acq. Operator : FIZa080210 Seq. Line : 12
Acq. Instrument : Instrument 1 Location : Vial 12
Injection Date : 08/02/2010 15:44:06 Inj : 1
Inj Volume : 1 µl
Acq. Method : C:\CHEM32\1\METHODS\ISOOCTANE230108.M
Last changed : 08/02/2010 11:27:14 by FIZa080210
Analysis Method : C:\CHEM32\1\METHODS\FATIMAH.M
Last changed : 23/03/2010 14:17:59 by fiza230310
(modified after loading)



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.858	BB	0.0322	37.20389	17.59138	0.00302
2	2.959	BV	0.0298	648.58887	332.55115	0.05267
3	3.010	VV	0.0364	1455.94348	607.90967	0.11823
4	3.106	VV	0.0420	149.01794	54.21088	0.01210
5	3.395	VV S	0.0972	1.00805e6	1.72876e5	[illegible].86163
6	3.584	VB S	0.0448	2.20250e5	8.19008e4	[illegible].88601
7	3.812	BB X	0.0292	730.86145	391.06586	0.05935
8	4.058	BB X	0.0322	53.53688	25.32040	0.00435
9	5.118	BV	0.0468	32.45870	9.64347	0.00264

Totals : 1.23141e6 2.56217e5

*** End of Report ***

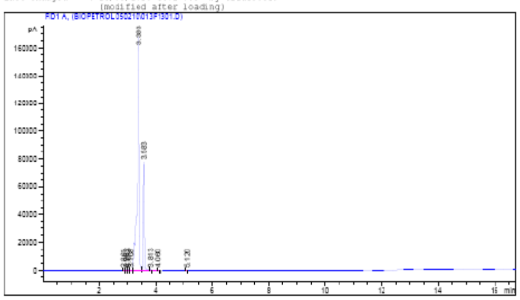
Instrument 1 23/03/2010 14:40:34 fiza230310 Page 1 of 1

Sample Y4

Figure D.3: Sample Y

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\013F1301.D
Sample Name: 8.1

Acq. Operator : FIZa080210 Seq. Line : 13
Acq. Instrument : Instrument 1 Location : Vial 13
Injection Date : 08/02/2010 16:07:22 Inj : 1
Inj Volume : 1 µl
Acq. Method : C:\CHEM32\1\METHODS\ISOOCTANE230108.M
Last changed : 08/02/2010 11:27:14 by FIZa080210
Analysis Method : C:\CHEM32\1\METHODS\FATIMAH.M
Last changed : 23/03/2010 14:27:59 by fiza230310
(modified after loading)



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.861	BB	0.0320	33.17862	15.77541	0.00291
2	2.962	BV	0.0302	580.83356	298.50970	0.05087
3	3.013	VV	0.0357	1311.40417	551.82574	0.11485
4	3.108	VV	0.0409	135.91428	51.27934	0.01190
5	3.393	VV S	0.0928	9.34179e5	1.67719e5	[illegible].81429
6	3.583	VB S	0.0440	2.04842e5	7.76375e4	[illegible].93979
7	3.813	BB X	0.0290	672.66864	357.18005	0.05891
8	4.060	BB X	0.0328	48.13805	22.22605	0.00422
9	5.120	BV	0.0392	25.90144	9.38993	0.00227
Totals :				1.14193e6	2.46662e5	

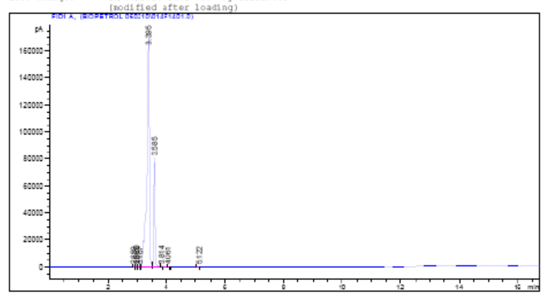
*** End of Report ***

Instrument 1 23/03/2010 14:41:07 fiza230310 Page 1 of 1

Sample Z1

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\014F1401.D
Sample Name: 8.2

Acq. Operator : FIZa080210 Seq. Line : 14
Acq. Instrument : Instrument 1 Location : Vial 14
Injection Date : 08/02/2010 16:30:31 Inj : 1
Inj Volume : 1 µl
Acq. Method : C:\CHEM32\1\METHODS\ISOOCTANE230108.M
last changed : 08/02/2010 11:27:14 by FIZa080210
Analysis Method : C:\CHEM32\1\METHODS\FATIMAH.M
last changed : 23/03/2010 14:27:59 by fiza230310
(modified after loading)



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.859	BB	0.0322	15.93518	7.53527	0.00131
2	2.960	BV	0.0302	461.39633	237.06622	0.03803
3	3.011	VV	0.0368	1127.92786	465.36526	0.09296
4	3.107	VV	0.0432	133.46275	49.08339	0.01100
5	3.395	VV S	0.0969	9.90518e5	1.70356e5	[illegible].63394
6	3.585	VB S	0.0453	2.20275e5	8.09607e4	[illegible].15404
7	3.814	BB X	0.0295	737.69202	390.36511	0.06080
8	4.061	BB X	0.0333	59.21886	26.78897	0.00488
9	5.122	BV	0.0444	36.94947	11.68422	0.00305
Totals :				1.21337e6	2.52504e5	

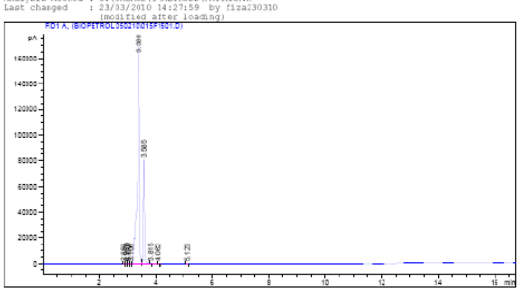
*** End of Report ***

Instrument 1 23/03/2010 14:41:55 fiza230310 Page 1 of 1

Sample Z2

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\015F1501.D
Sample Name: 8.3

Acq. Operator : FIZa080210 Seq. Line : 15
Acq. Instrument : Instrument 1 Location : Vial 15
Injection Date : 08/02/2010 16:53:41 Inj : 1
Inj Volume : 1 µl
Acq. Method : C:\CHEM32\1\METHODS\ISOOCTANE230108.M
Last changed : 08/02/2010 11:27:14 by FIZa080210
Analysis Method : C:\CHEM32\1\METHODS\FATIMAH.M
Last changed : 23/03/2010 14:27:59 by fiza230310
(modified after loading)



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.858	BV	0.0329	31.11638	14.56786	0.00253
2	2.959	VV	0.0304	603.50970	306.93414	0.04904
3	3.010	VV	0.0370	1385.00598	568.38392	0.11288
4	3.106	VV	0.0427	149.92206	54.15682	0.01218
5	3.396	VV S	0.0985	1.00622e6	1.70245e5	[illegible].76834
6	3.585	VB S	0.0455	2.21363e5	8.11439e4	[illegible].98871
7	3.815	BB X	0.0297	712.28333	375.02608	0.05788
8	4.062	BB X	0.0336	73.55166	32.92749	0.00598
9	5.123	BV	0.0415	30.30488	10.16939	0.00246
Totals :				1.23057e6	2.52770e5	

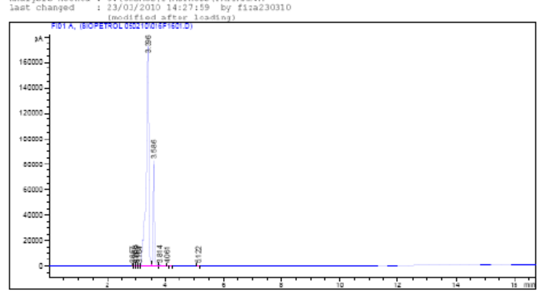
*** End of Report ***

Instrument 1 23/03/2010 14:42:29 fiza230310 Page 1 of 1

Sample Z3

Data File C:\CHEM32\1\DATA\BIOPETROL 050210\016F1601.D
Sample Name: 8.4

Acq. Operator : FIZa080210 Seq. Line : 16
Acq. Instrument : Instrument 1 Location : Vial 16
Injection Date : 08/02/2010 17:16:57 Inj : 1
Inj Volume : 1 µl
Acq. Method : C:\CHEM32\1\METHODS\ISOOCTANE230108.M
last changed : 08/02/2010 11:27:14 by FIZa080210
Analysis Method : C:\CHEM32\1\METHODS\FATIMAH.M
last changed : 23/03/2010 14:27:59 by fiza230310
(modified after loading)



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: FID1 A,

Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	2.857	BV	0.0323	28.86569	13.55428	0.00224
2	2.958	VV	0.0305	605.60034	307.02615	0.04700
3	3.009	VV	0.0373	1434.44409	580.46948	0.11133
4	3.104	VV	0.0432	154.60757	55.21782	0.01200
5	3.396	VV S	0.1013	1.04991e6	1.72770e5	[illegible].48442
6	3.586	VV S	0.0469	2.33054e5	8.27784e4	[illegible].08754
7	3.814	VB S	0.0773	3208.67407	692.06921	0.24903
8	4.061	BB X	0.0321	52.31269	24.30217	0.00406
9	5.122	BV	0.0406	30.73680	10.81779	0.00239
Totals :				1.28848e6	2.57232e5	

*** End of Report ***

Instrument 1 23/03/2010 14:43:13 fiza230310 Page 1 of 1

Sample Z4

Figure D.4: Sample Z

CHAPTER 1

INTRODUCTION

1.0 Introduction

Now days, are lot of people know uses and benefits of biofuel and biofuel groups such as bioethanol, biodiesel, biogas and biopetrol has a huge potential to replace petroleum fuels in the future because there unlimited resource. Biofuel derived from plant and animals oils recently has attracted the researchers about the capabilities and renewably. Other than environmental friendly, biofuel can improve the engine vehicle efficiency and this has been proved through research that has been done. For example biodiesel, it can be performed excellent energy balance (input: 1 / Output: 2.5) which would be 78% greater than standard diesel (Herschel, 2007). Generally, biofuel is defined as a liquid or gaseous fuel that can be produced from the utilization of biomass substrates according to Giampietro et al. (Tamunaidu and Bhatia, 2006). In this research, production of biopetrol by using fatty acid as the raw material is the main topic that being focused.

Commonly, natural triglycerides present in vegetable oil are extracted into several oil components using transterification route but it generates a large amount of glycerin (byproduct) thus difficult to purify. Therefore, heterogeneous catalytic cracking method is suggested. However, triglyceride molecules are too large to enter the pores of Zeolite (Dupain *et al*, 2006) during heterogeneous catalytic cracking; therefore this research is proceeding within vegetable oil derived or fatty acid into biopetrol at 1 atm and at 98 ^oC. In this case, oleic acid ($C_{18}H_{34}O_2$) has been chosen for conversion into isooctane which also the major constituents of biopetrol since that oleic acid contain low in sulfur and nitrogen besides it also encounter more than 40% constituents inside most of the vegetable oil such as palm oil, olive oil, rapeseed and others. Beside, Zeolite also is chosen because it possesses a catalytic activity that is much higher than other types of catalysts because of its high selectivity properties.

Twaiq *et al* in his paper claimed that, recently several researchers have been successful in production of hydrocarbons from palm oil mainly bio-gasoline or biopetrol (Tamunaidu and Bhatia, 2006) which have been carried out using cracking catalysts in a micro-reactor but still not valid for commercialize. It also has generated a significant of interest of Palm Oil Research Institute of Malaysia (PORIM) in development of biodiesel from palm oil. (Hussain *et al*, 2006).

1.1 Problem Statement

Currently, the world is depending to the only major source of energy as known as the petroleum fossil fuel. It is a nonrenewable energy and the next few decades the source to the crude oil will be finished. The idea of this research is to solve out the fuel crises that really need to have other alternative.

As we know, now day the amounts of petroleum fossil reserve in this world are decreasing and this problem also includes Malaysia such as the saying of Prime Minister Datuk Seri Najib Razak ***"Malaysia is an oil exporter, but if we do not find new oil reserves, then by 2009, we will become a net importer".*** Since then, the prices of fuel are increasing gradually every year. Figure 1.1 is the fuel price in Malaysia from May 2004 to June 2008 and as we can see the fuel price increase from RM 1.37 per Liter to RM 2.70 per Liter in this four year. After June 2008, the fuel price starts to decrease slowly until RM 1.80 per Liter 2009 for RON95 and it maintain until now. Figure 1.2 shows the decreasing fuel price after June 2008. This price is still the highest compared to the price in May 2004.

Figure 1.1 : Fuel Price in Malaysia from May 2004 to June 2008

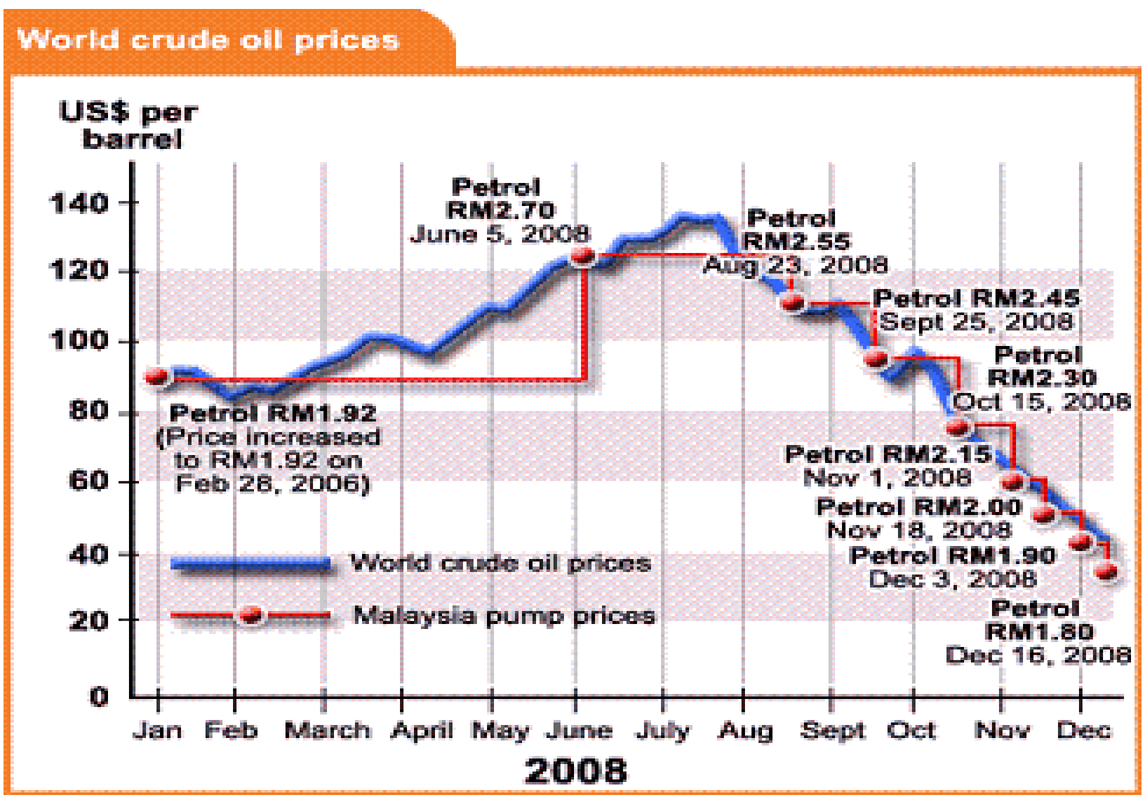


Figure 1.2 : World Crude Oil & Malaysia fuel Prices from Jan to Dec 2008.

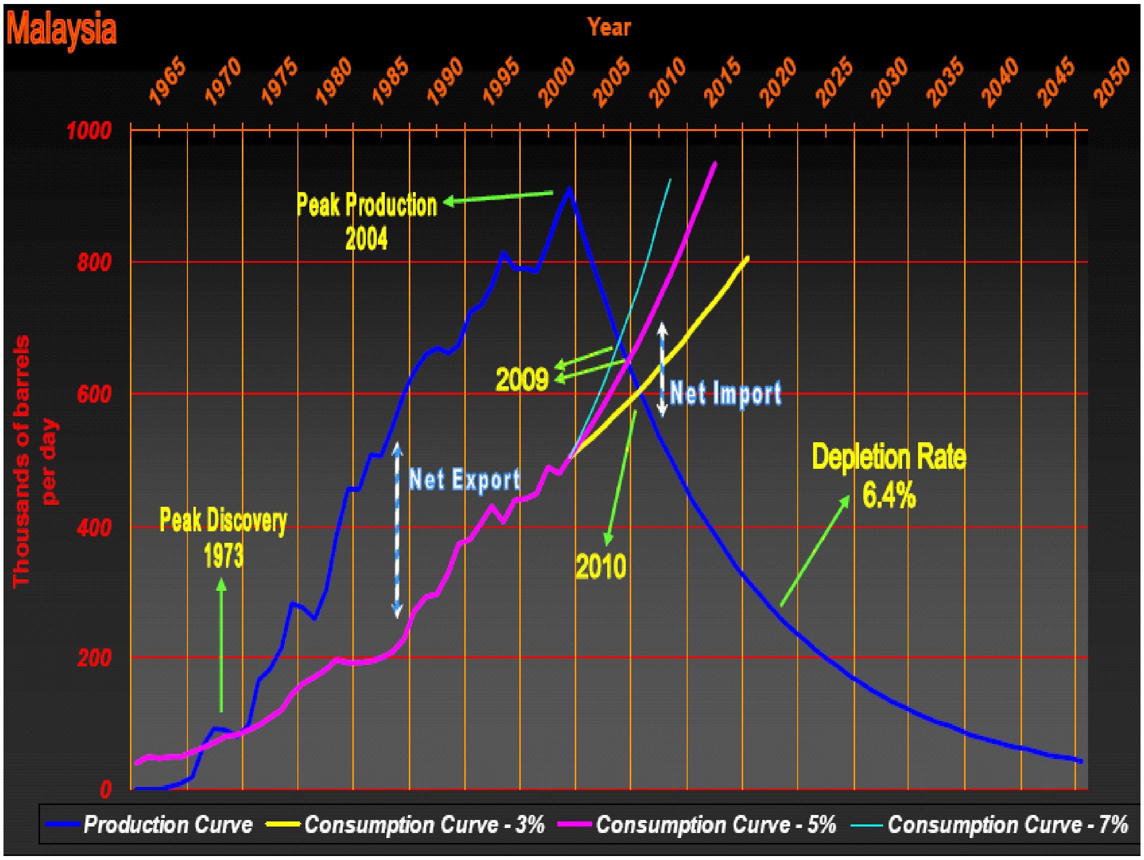


Figure 1.3 : Malaysia's Looming Energy Crisis (M. Noor, 2008)

Malaysia is the one of the major oil exporters in the world. Malaysia also has the crisis of the declining of these mineral sources. Malaysia's oil production is decreases in 2004 and would then decline by 6.4 percent annually. Figure 1.1 shows the declining Malaysia oil's production by 2004. Forecast, by 2009 to 2010 Malaysia will become a net importer because out of mineral sources (petroleum) and the demand of oil increasing. From figure 1.4, the blue line represents the production of oil which is 820,000 barrels per day in 1998 and decreasing to 620,000 barrels per day in 2008. Within 10 years from now, all of crude oils will finish up without any preservation awareness. Figure 1.2 shows the fuel price in Malaysia from May 2004 to Jun 2008. Bio-petrol is one of bio-fuels which can be fuel alternatives in substituting petrols and diesel.

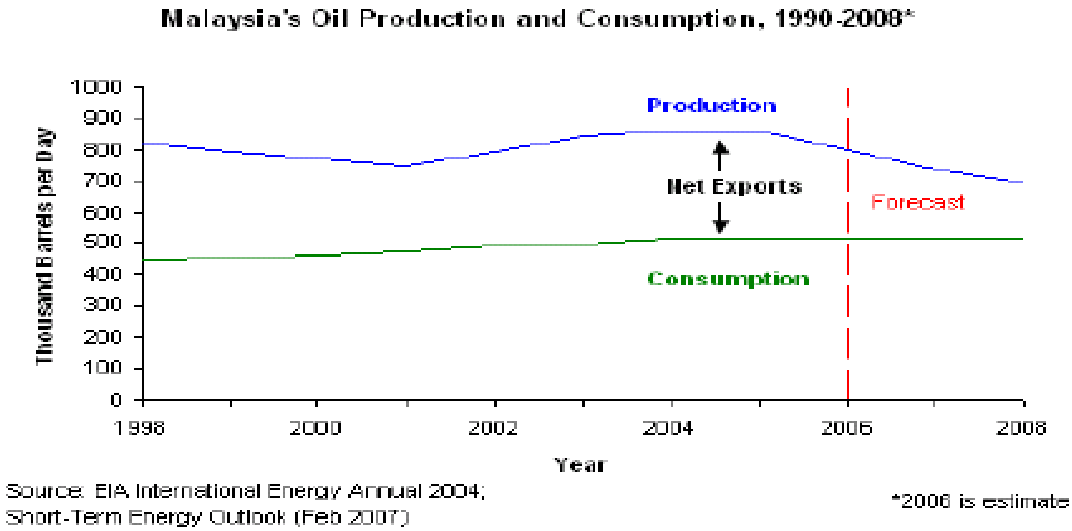


Figure 1.4: Malaysia's Oil Production and Consumption

Now, a few plants are using biomass energy technologies use waste or plant matter to produce energy with a lower level of greenhouse gas emissions than fossil fuel sources. Most of countries aware of this issue and they tend to develop research and modern technology to produce biofuels.

At an average, about 0.1 tonne of Palm Oil Mill Effluent (POME) is generated for every tone of fresh fruit bunch processed. POME consists of water soluble components of palm fruits, saturated fatty acids as oleic acid, stearic acid and palmatic acid and also suspended materials as palm fiber and oil. Despite of its biodegradability, the POME cannot be discharged without treating it. This is because POME is very acidity and could pollute environment. By thinking of this, producing biopetrol from the POME can be the alternative solutions for treating the POME. At the same time, contribute to the production of biopetrol from the fatty acids.

Oleic acid is the dominative component in palm oil waste. Its disposal into water supply sources causes serious water pollution. Besides that the loss of oleic acid as a useful industrial component also occurs so that it is not utilized much and always eliminated to improve and upgrade the quality of crude palm oil. Thus, it is disposed as palm oil waste and then pollutes water resources by its spillage. Producing petrol from the waste of palm oil will give an alternative choice to the users, especially for petrol-engine vehicles' owners. In addition, this biopetrol, which is graded 100 for its octane number, burns very smoothly so biopetrol can reduce emissions of some pollutants (Omar, 2005).

According to the previous research, the yield of biopetrol using thermal cracking is very small. In this research, the concentration of isooctane that is produced from oleic acid and also the conversion of fatty acids to form desired isooctane in biopetrol will be improved by using heterogeneous catalytic cracking process and use zeolite as catalyst.

1.2 Objectives

I. To analyze isooctane obtained from oleic acid ($C_{18}H_{34}O_2$).
II. To find and determine concentration of synthesized biopetrol obtained.
III. To improve the concentration of biopetrol (isooctane) obtained from oleic acid using zeolite as catalyst through-Heterogeneous catalysis.

1.3 Scopes of Study

In order to accomplish the objectives, the scope of this research is focusing on the criteria that are stated as below:-

I. Application of the heterogeneous catalytic cracking process to crack the long-chain oleic acid molecules into the smaller hydrocarbon molecules instead of previous thermal cracking.
II. Identification of the composition of isooctane using Gas Chromatography method.
III. Determination of the amount of isooctane through analysis using Gas Chromatography method.

IV. Description of the molecular arrangement during isomerization of oleic acid through catalytic cracking process with the presence of catalyst.

V. Comparison of isooctane obtained and the mode of catalysis process with previous research.

1.4 Rational and Signification

I. Biopetrol is biodegradable and renewable resource, able to sustain the energy supply for transportation.

II. Oleic acid can be found easily in most vegetable oil especially in palm oil (Malaysia) and wider the palm oil application for biopetrol.

III. The rate of plant growth is much faster than the formation of petroleum oil thus plant has widely potential as sustainable energy.

IV. Isooctane (B100) obtain in biopetrol by catalytic cracking reduce the hydrocarbon chain cause effective combustion in petrol engine and increase engine life.

V. Biopetrol is sulphur free and able to reduce the emission of green emission gas more than 40 percent.

VI. Catalytic cracking provide higher conversion of hydrocarbon than thermal cracking does by lowering the activation energy of the reaction.